XXII FAUNA SYMBIOTICA INDICA

No. 4.—*CARIDINICOLA*, A NEW TYPE OF TEMNOCEPHALOIDEA.

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The object of the present note is to give a concise systematic description of an interesting symbiotic flatworm and to state what little is known of its habits. In preparing the description I have been indebted to the assistance of Mr. F. H. Gravely, who will, I hope, publish before very long a detailed anatomical account of the Temnocephaloidea represented in the collection of the Indian Museum and will discuss the morphology of the species described below.

I. *SYSTEMATIC.*

Class TEMNOCEPHALOIDEA.

It is perhaps doubtful whether the members of the so-called class Temnocephaloidea are sufficiently distinct from the Trematoda to be given that rank, and the peculiar little worm discussed in this paper is in many respects intermediate between the two "classes." For the present, however, the recognized classification may be accepted as convenient.

The Temnocephaloidea or Temnocephala, whatever their precise rank, are small parasitic flatworms with tentacles at the anterior end of the body and a large ventral sucker at the posterior extremity. They have a capacious sack-shaped alimentary canal with an anterior mouth but without a posterior aperture. The external surface is clothed with a delicate chitinous cuticle but in some cases bears cilia on certain parts of the body. Immediately below the cuticle there is a definite epidermis, in which, however, cell-walls do not occur. The genital organs lie behind or on the ventral surface of the alimentary canal in the posterior part of the body; the genital pore is situated near the posterior extremity or in the middle of the ventral surface.

A single species (*Scutariella didactyla*)[1] has been found in Europe but the group as a whole is characteristic of tropical and subtropical, or at any rate southern countries. It apparently has its headquarters in Australia, but is also found in New Zealand, in Malaysia and in S. America. Only one Indian species [Wood-Mason (12)] has hitherto been identified,[2] namely *Temnocephala semperi*, Weber, which is common on freshwater

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[1] Mrázek, *Sitz. K. Böhm. Gesellsch. Wiss. Prag* 1907, p. 1, pl.

[2] Mr. Gravely has recently identified specimens after comparison with some of Prof. Max Weber's original examples from Java.

crabs of the genus *Potamon* (especially *P. manii*, Rathbun) in hill-streams in parts of Tenasserim.

The Temnocephaloidea appear to be confined to fresh water and to live, without exception, symbiotic rather than parasitic lives. In habits they are predaceous, but they invariably attach themselves to a host which they can conveniently employ as a beast of burden and a stalking-horse in the pursuit of their prey. Each species affects a single host or a group of closely allied hosts. Most of the Temnocephaloidea are found attached to Decapod Crustacea; the Australian species inhabit the gill-chamber of crayfish; the Malayo-Burman *Temnocephala semperi* lives on the ventral surface of crabs; one S. American form attaches itself to equatic tortoises, while another penetrates within the pulmonary chamber of the Gastropod *Ampullaria*. The species to be discussed in this paper, like the allied European form, is associated with small prawns of the family Atyidae.

The Temnocephaloidea may conveniently be divided into three families as follows:—

I. At least four anterior tentacles; posterior sucker circular; alimentary canal much shorter than body, with the genital organs posterior to it.

A. No lateral tentacles; no anterior sucker; pulsatile excretory pouches present . TEMNOCEPHALIDAE.

B. Lateral as well as anterior tentacles; an anterior sucker in front of the mouth; no pulsatile excretory pouches. ACTINODACTYLELLIDAE.

II. Only two anterior tentacles; anterior margin of posterior sucker cleft; alimentary canal extending to posterior extremity, with the genital organs on its ventral surface; no pulsatile excretory pouches SCUTARIELLIDAE.

The third family appears to be considerably more remote from the two first than either of the latter is from the other, but it has not hitherto been recognized as distinct. It consists of two allied genera, *Scutariella*, Mrázek, and *Caridinicola*, gen. nov. The former is known from a single species from Montenegro; the latter from a single Indian species. The family may therefore be said to agree with most of the secondary divisions in the Temnocephaloidea in consisting almost of a minimum of forms. Only 5 genera (*Temnocephala*, *Craspedella*, *Actinodactylella*, *Scutariella* and *Caradinicola*) are known in the "Class" and of these *Temnocephala* is the only genus that is not monotypic, while the Temnocephalidae is the only family hitherto recognized that includes more than one genus, *Craspedella* as well as *Temnocephala* belonging to it.

Fam. SCUTARIELLIDAE, nov.

The two species included in this family are both minute, flattened, more or less ovoid or shield-shaped organisms associated with little freshwater prawns of the family Atyidae. They differ from all other known Temnocephaloidea in the following characters:—

(1) There are only two anterior tentacles, which differ in structure and function from those of *Temnocephala*.
(2) The posterior sucker is cleft anteriorly in such a way that it becomes either heart-shaped or horseshoe-shaped.
(3) There are no external cilia on any part of the body.
(4) The alimentary canal extends backwards to the posterior extremity.
(5) The genital organs lie beneath instead of behind the alimentary canal and the genital pore is situated in the middle of the ventral surface.

In the absence of lateral tentacles the Scutariellidae agree with the Temnocephalidae but they resemble *Actinodactylella*, Maxwell (7, 8) in the absence of pulsating excretory pouches and in the arrangement of the genital organs. The external cuticle is minutely ringed.

CARIDINICOLA, gen. nov.

The mouth is almost precisely terminal and the whole pharynx can be extruded in the form of a proboscis. The tentacles arise on the dorsal surface, one on either side of the mouth. At the base of each tentacle, on the ventral surface, there is a small sucker. The posterior sucker is horseshoe-shaped. The excretory system opens on either side by a pore on the lateral margin almost on a level with the eyes. There are two testes on either side, a larger and more conspicuous external and anterior testis and a smaller inner and internal one. The penis is armed with chitin and directed from right to left; the ovary resembles that of *Temnocephala* in structure and lies a little to the left of the middle line; the vitellarium does not cover the dorsal surface of the alimentary canal. Each tentacle has a large ganglion at its base. An elongated gland runs along each side of the anterior part of the body towards the tip of the tentacle.

Type, *Caridinicola indica*, nov.

Distribution.—The Ganges and the Mahanaddi rivers, eastern India.[1]

CARIDINICOLA INDICA, sp. nov.

External characters.—The animal is highly contractile and almost protean in form, but is always flattened dorso-ventrally, more or less produced at the anterior end and truncate posteriorly.

[1] Since this was written Mr. Gravely has obtained specimens of *Caridinicola* on *Caridina sumatrensis* in the Western Ghats.

When normally contracted it resembles a median longitudinal section of a cone in outline. In length an adult individual can extend instantaneously from 0·5 mm. to 2·0 mm. The integument is colourless and transparent and the rings on the cuticle very narrow. The tentacles are extremely short and have a bluntly rounded tip; they are soft and apparently devoid of cuticle; when the animal is fully extended they have the appearance of being mounted on short peduncles. The mouth opens between them at the base of a depression which becomes crateriform when the proboscis is fully retracted and the whole animal fully extended. There are two eyes situated on the anterior half of the dorsal surface some distance behind the base of the tentacles; the eyes are directed forwards and outwards; they are black in colour.

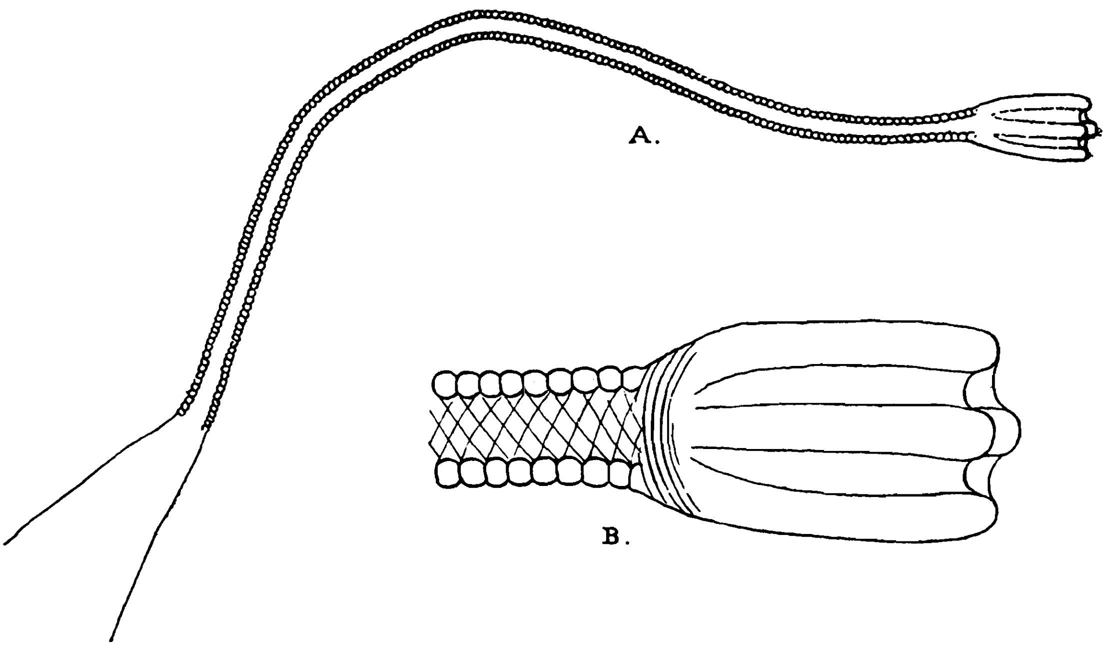


FIG. 1.—Chitinous armature of intromittent organ of *Caridinicola indica*.
A.—The entire armature, very highly magnified.
B.—The terminal cup, still more highly magnified. The stem or intermediate portion and the basal funnel are represented in optical section.

When the animal is fully contracted the posterior sucker sometimes becomes almost heart-shaped, but as a rule it resembles the figure formed by a straight line the extremities of which are curved upwards through the greater part of a circle, the distance apart of the incomplete circle thus formed varying with the state of contraction of the animal.

Alimentary canal.—The mouth opens into an elongate cylindrical but highly muscular pharynx (oesophagus) which can be thrust out bodily to nearly half the length of the animal. The tip of this organ is surrounded by a circle of minute prominences on each of which a sense-organ provided with a minute chitinous tooth is situated; the whole ring is folded inwards when the proboscis is retracted. Strong, almost transverse retractor muscles, are

attached to the base of the pharynx. The intestine is rather longer and much more bulky than the pharynx; it is indistinctly sacculated at its anterior end.

Genitalia.—Only the penis need be described here. The chitinous part of this organ (fig. 1) consists of three regions:—(1) a proximal, funnel-shaped base, (2) an elongate cylindrical stem and (3) a cup-shaped apex. The basal funnel occupies about $\frac{1}{8}$ of the length of the whole structure and has a perfectly smooth external surface; it is almost twice as long as its basal diameter. The stem is about 34 times as long as its own transverse diameter, maintains the same diameter throughout its length, is circular in cross-section and occupies $\frac{5}{6}$ of the whole structure. It is ornamented externally with minute rounded prominences with which it is closely covered, the prominences forming parallel transverse rings round it. The terminal cup is about $1\frac{1}{3}$ times as long as broad and only about $\frac{1}{10}$ the length of the stem. Its sides, which are nearly parallel, are supported by four equidistant vertical bars, each of which is about equal in breadth to the space which separates it from the next bar. At the rim of the cup the bars project upwards for a short distance, their tips being bluntly rounded.[1]

Excretory system.—A pore which I believe to be excretory is situated on each side of the body close to the edge of the dorsal surface and a little posterior to the eye. These pores are easily seen in living specimens.

Eggs.—The eggs are nearly circular as seen from the side but broadly oval as seen from above. Each is provided with a stalk considerably shorter than its own diameter. They are somewhat variable in size but measure on an average about 0·24×0·19 mm. in dorsal view. The external covering is chitinous but very thin and quite smooth; it has a distinct yellowish tinge.

Type (a specimen mounted in glycerine) No. Z.E.V $\frac{5060}{7}$, Ind. Mus.

Localities, etc.—River Mahanaddi and canal opening thereinto at Cuttack and R. Mahanaddi at Sambalpur, Orissa (February and March); river Ganges near Rajmehal, Bengal (March) (*B. L. Chaudhuri*).

Hosts.—*Caridina propinqua*, de Man (4) and *C. sumatrensis*, Bouvier (3).

II.—BIOLOGICAL.

The first specimens of *Caridinicola* were found attached to antennae of prawns of the genus *Caridina* taken at Cuttack in February and preserved in spirit. Others were discovered loose in the same bottle. They were, naturally enough, mistaken for small leeches by my assistant who was sorting out the contents of the bottle. As the species was evidently one of considerable interest, I took the opportunity to revisit Cuttack last March and found the worm abundant in the gill-chambers of *C. propinqua*,

[1] These details can only be seen with the aid of an oil-immersion lens after the specimen has been treated with caustic potash.

which swarmed among water-weeds at the edge of the Mahanaddi and also in a canal at the same place. Loose specimens were subsequently found in bottles of *Caridina sumatrensis* from Sambalpur in Orissa and Rajmehal in Bengal.

In the river and canal at Cuttack small Decapod and Schizopod Crustacea are extremely abundant. At least three species of *Caridina* (*C. nilotica*, Roux) (*s.l.*), *C. propinqua*, de Man, and *C sumatrensis*, Bouvier, occur among weeds at the edge, and also numerous small (mostly immature) Palaemonidae; while the water is often full of large shoals of the little estuarine Mysidae *Potamomysis assimilis* and *Macropsis orientalis*, Tattersall (10).

In spite of a careful search, I did not find *Caridinicola* on any species of *Palaemon* or Mysidae at Cuttack or on *Caridina nilotica.* I cannot, however, be sure that it did not occur on *C. sumatrensis*, although all the specimens of *Caridina* on which I know that I took it are assigned by Mr. Kemp to *C. propinqua*; for the immature individuals of the two prawns resemble one another very closely.

I have not been able to find *Caridinicola* on *Caridina propinqua* in the neighbourhood of Calcutta, but this may be due to the fact that the prawn in this district is only found in distinctly brackish water, whereas the water of the Mahanaddi at Cuttack is very nearly, if not quite, fresh. That of the Mahanaddi at Sambalpur and of the Ganges at Rajmehal is of course quite fresh. Nothing is yet known of the distribution of *Caridina propinqua*, which has hitherto been recorded only from the Ganges delta, but it is very closely related indeed to *C. fossarum*, Heller, from Persia, and it is probable that closely allied forms extend all over the territory intermediate between that country and Lower Bengal. *C. sumatrensis* appears to be distributed over a considerable part of the Oriental Region.

The host of *Scutariella* is *Atyäephyra desmarestii*, the only non-cavernicolous European Atyid.

The habitual position of *Caridinicola* on its host is inside the gill-chamber, in which it lies attached to the gills. In most cases it can be readily detected in this position with the aid of a low-power microscope by an external examination of the prawn, whose integument is rarely pigmented so deeply as to render the operculum opaque. If the water in which the prawn is living, however becomes foul or if any noxious substance is added to it, the worm immediately emerges from the anterior end of the chamber and makes its way rapidly along the antenna or antennule. After gesticulating wildly in a manner that will be described presently, it then makes off in search of a new environment, being by no means wholly dependent on the prawn for the power of locomotion. For this reason very few specimens can be found on prawns which have been kept in captivity for more than a few hours, unless precautions are taken to keep the water fresh.

Caridinicola, though not markedly gregarious, is usually found in parties of two or three and, so far as my observations go,

such parties are usually confined to one gill-chamber, that on the other side of the prawn remaining vacant.

The eggs are attached to the gill-filaments of the host and are apparently deserted by their parent before they hatch. I found numerous examples far advanced in development at the beginning of March. There are as a rule not more than half a dozen on one host.

The food of *Caridinicola* consists mainly if not entirely of minute Protozoa and Protophyta. The contents of the alimentary canal as a rule consists of a brownish granular substance, probably excretory and containing large numbers of Diatom and Desmid skeletons. The tests of Rhizopod Protozoa are often present also in considerable numbers.

Prey is evidently captured by means of the pharynx, which can, as already stated, be thrust out bodily in the form of a pro-

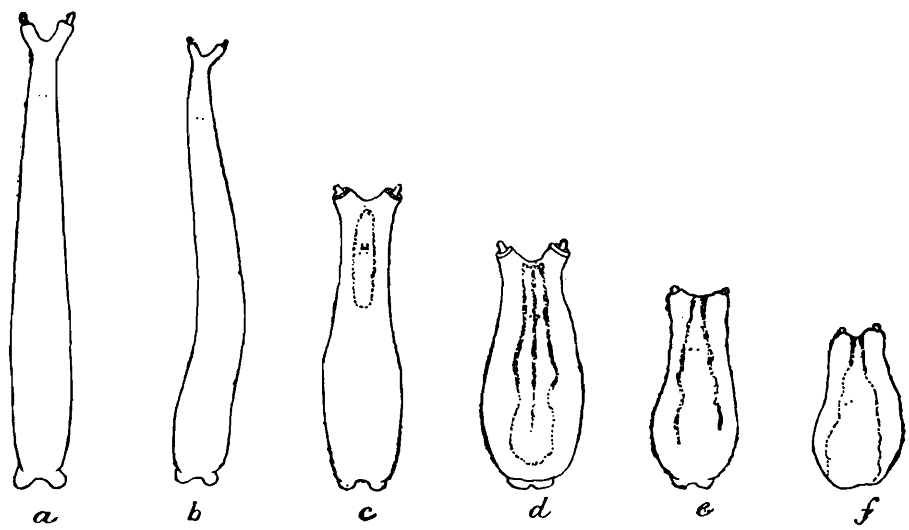


FIG. 2.—A single individual of *Caridinicola indica* in different stages of contraction.

boscis. I have not been so fortunate as to see the process, but Babu Abohya Charan Chowdhary, the Museum draftsman, tells me that while he was drawing the sketches reproduced in fig. 2, he saw the worm suddenly shoot out its proboscis and seize therewith a "small insect" which was running past. The proboscis was then rapidly withdrawn. The "small insect" was probably an Infusorian. The animal can easily be induced to extrude its proboscis by the exercise of pressure. Apparently the extrusion takes place more readily when the whole body is in a state of moderate contraction and is brought about by lateral contraction of the muscles of the body-wall, which are very well developed, aided by those of the organ itself. Retraction is affected by means of the retractor muscles situated at the base of the oesophagus. Doubtless the sense-organs surrounding the mouth enable the animal to decide whether the prey captured should be swallowed

or rejected, while the little teeth with which they are provided assist in its retention.

When *Caridinicola* is undisturbed in the gill-chamber of its host it habitually remains with its body in a state of moderate retraction, approximately as in fig. 2 *d*. The posterior sucker is firmly fixed to a gill-filament and the body is arched upwards and forwards in such a way that the eyes look directly forwards and outwards, the anterior extremity being bent considerably downwards. If any disturbance occurs, however, the animal immediately straightens itself and elongates its body to the utmost. Such attitudes as those shown in fig. 2 *a* and *b* are only adopted just before it begins to move forwards. Apparently the rule that it emerges from the anterior end of the gill-chamber is absolute, and it invariably escapes *viâ* the antenna or antennule. As soon as it reaches the filamentous part of one of these appendages it stays its course and remains for some little time with the peculiar posterior sucker clasped round the hair like structure. The body is stretched to the utmost and moves rapidly upwards and downwards and from side to side, often gyrating almost as if on a pivot; but the sucker retains a firm hold. The tentacles during these evolutions exhibit curious twitching movements apparently neither correlated in the case of the two tentacles nor rhythmical. At length the *Caridinicola* releases hold of its host and drops to the bottom or onto a convenient weed. It seems probable that it habitually deserts its host at night, for I found it difficult to procure specimens on *Caridina* in the Mahanaddi early in the morning.

Progression is effected by means of "looping." The body is first held upright and stretched to the greatest possible length. The anterior extremity is then bent downwards and the surface along which progression is to be effected touched gently by the tentacles with their characteristic twitching movements. The two little anterior suckers next take hold, and the posterior sucker is released, drawn forward to a position immediately behind that occupied by them and then affixed again. The animal is now in readiness for a new move forwards.

Taking the above-stated observations into consideration, it seems probable that the tentacles are, as their structure would suggest, primarily of use as sensory organs. They seem to play no other part in progression than that of testing the ground before the anterior suckers attach themselves to it. They have, I think, another function, namely that of finding the right host. I noticed that if a *Caridinicola* were removed from its host and placed in a dish of water in which a *Caridina* of the right species was present, it immediately stood up in the water on its posterior extremity and, after twisting about in all directions and flicking its tentacles, finally directed them in the direction of the *Caridina* and then moved rapidly towards it. This happened whether the *Caridina* was dead or alive; indeed, even if it were torn in pieces, the little worm appeared to be attracted by the fragments and attached itself to one of them.

The eyes probably serve another purpose. As the worm sits in the gill-chamber of its host, they are, as I have already stated, directed straight in front of it. The current of water that flows constantly through the gill-chamber must bring in many of the little organisms on which *Caridinicola* feeds, and it is reasonable to assume that it catches these organisms by means of its protrusible pharynx. In order to do so, however, it must first become aware of their presence. There is every probability that it does so by seeing them, for the walls of the gill-chamber of *Caridina propinqua* are of glassy transparency and offer hardly any obstacle to the passage of light, while even those of *C. sumatrensis*, although they are as a rule much more densely pigmented, are by no means opaque.

SUMMARY

1. The new genus *Caridinicola* constitutes with *Scutariella*, Mrázek, a family of "Temnocephaloidea" of which the latter is the type.

2. The family Scutariellidae is distinguished from other families of the group, among other characters, by the fact that the intestine extends to the posterior end of the body and that the genital organs, therefore, lie on its ventral surface instead of posterior to it.

3. *Caridinicola* is distinguished from *Scutariella* by the possession of a pair of small anterior suckers, by the terminal position of the mouth and by the peculiar shape of the posterior sucker.

4. *Caridinicola indica* is found only in association with certain species of the Atyid genus *Caridina*, namely *C. propinqua*, de Man, and *C. sumatrensis*, Bouvier.

5. It captures its prey by means of a protrusible pharynx or oesophagus.

6. Its tentacles are sense-organs and are apparently employed in testing the nature of the surface along which the animal is moving and also in finding the host.

7. The eyes are probably used for the detection of prey.

8. Progression is affected by "looping."

In conclusion I must again express my indebtedness to Mr Gravely and also to Mr. Stanley Kemp, who has given me great assistance in identifying the hosts of *Caridinicola indica.*

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